# Global Ocean Heat and Salt Content

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## CDR Image

### Global Ocean Heat Content

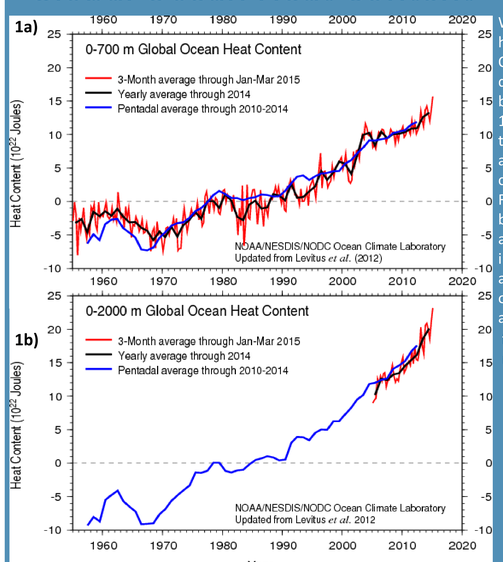



Figure 1. a) shows the 0-700 meter layer and b) shows the 0-2000 meter layer. The 0-700m layer's OHC has been computed at running pentadal (5-year), yearly, and seasonal resolutions since 1955.

We provide a time series of ocean heat content (OHC) for the World Ocean. Due to limited historical deep depth profiles, the 0-2000m layer has been computed pentadally since 1955, and only recently (~2005, due to global coverage of Argo) has annual and seasonal OHC computations been made.

For the past 4 years our group has been publishing yearly, zonally averaged salinity anomalies and interannual changes in these anomalies as part of the BAMS State of the Climate report (See Boyer et al., 2015 for most recent).

### Global Ocean Salt Content

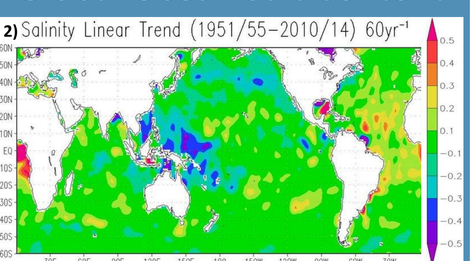



Figure 2. The 60 yr linear trend of sea surface salinity anomalies calculated from the pentadal salinity anomalies from 1951-1955 through 2010-2014.

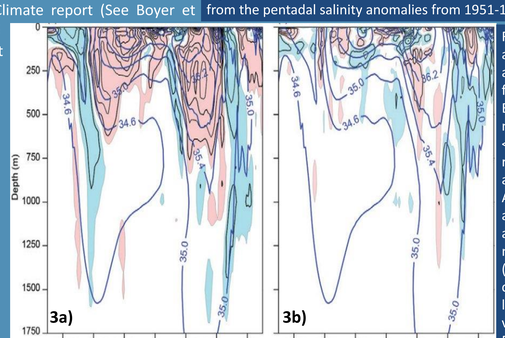



Figure 3. a) 2014 zonal average salinity anomaly and b) 2014 minus 2013 for the Atlantic Ocean. Blue shading represents negative (fresh anomalies <0.01, red shading represents positive (salty) anomalies >0.01. Anomalies are contoured at 0.02 intervals. Zonally averaged climatological mean salinity values (Antonov et al. 2010) are contoured (thick blue lines) at 0.4 intervals. All values are reported as PSS-78.

## CDR Description

### World Ocean Database

**WOD** is a collection of quality controlled oceanographic profile data (43 variables) collected from multiple instruments. See Boyer et al., (2013) for complete review of WOD.

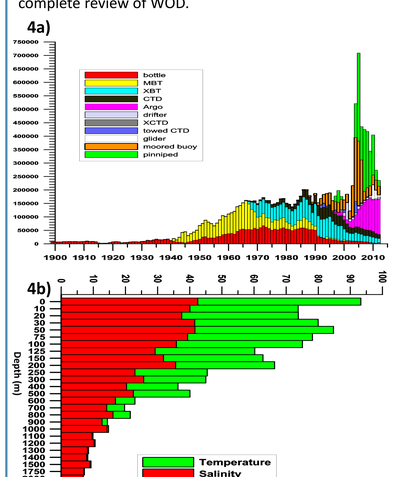



Figure 4. a) Number of profiles added to WOD by year and instrument type and b) Number of temperature and salinity measurements ($X10^5$) in WOD per depth level.

### World Ocean Atlas

**WOA** is a set of objectively analyzed (1° and 0.25° grid) climatological fields of in situ variables such as temperature and salinity at standard depth levels for multiple time periods for the world ocean. See www.nodc.noaa.gov/OC5/woa13.

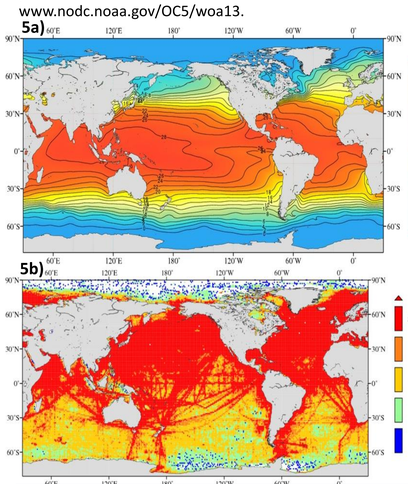



Figure 5. a) Annual temperature (°C) at the surface (decadal average: 1955 - 2012; one-degree grid and b)number of temperature observations for the calculation of 5a.

### Anomalies

**Temperature and salinity anomalies** are objectively analyzed (1 ° grid) differences between the measured value (at standard depth level) and the climatological mean for each depth.

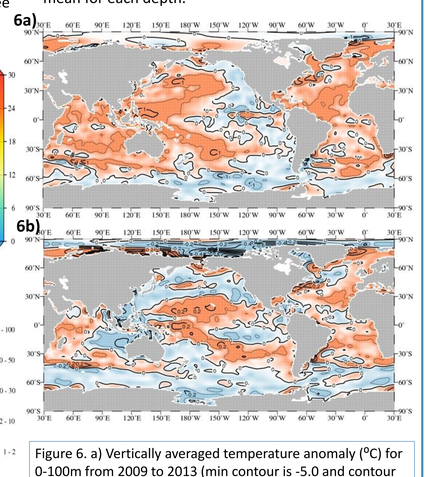
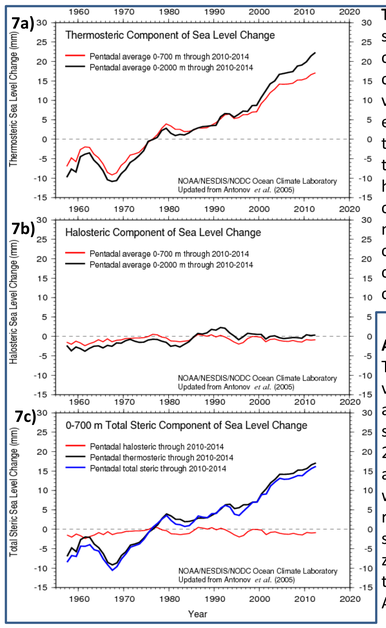



Figure 6. a) Vertically averaged temperature anomaly (°C) for 0-100m from 2009 to 2013 (min contour is -5.0 and contour interval is 0.5) and b) vertically averaged salinity anomaly for 0-100m from 2009 to 2013 (min contour is -2.0 and contour interval is 0.1). Blue shading means negative (freshening) anomalies and red means positive (saltier) anomalies.

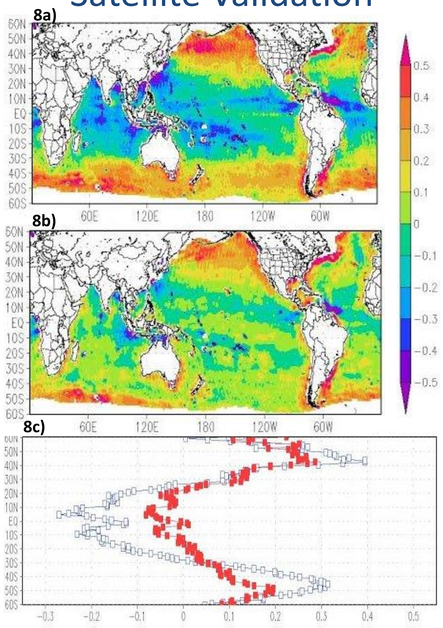
## Current applications based on the CDR

### Sea Level Change




**Thermosteric** sea level change is the variation in sea surface height caused by expansion and contraction of ocean volume due to temperature changes. **Halosteric** sea level change is the variation in sea surface height caused by the expansion and contraction of ocean volume due to changes in salinity. Fig. 7a shows the thermosteric component and Fig. 7b shows the halosteric component time series of sea level change for 0 – 700 meters in red and 0 – 2000 meters in black. Fig. 7c shows the time series comparing thermosteric and halosteric sea level change at 0 – 700 meters. The thermosteric component contributes more to sea level change.

### Satellite Validation




**Aquarius Satellite Validation**

The average monthly difference between Aquarius v3.0 (Fig. 8a standard release (ADPS) and Fig. 8b CAP algorithm) and the WOD-derived near-surface salinity fields from September 2011 to December 2014. The figure reveals where Aquarius and in situ are consistently different. Warm colors represent where satellite is greater than in situ and cool colors represent where satellite is less than in situ. Fig. 8c shows the zonal average of Fig. 8a and Fig. 8b. The zonal average differences are much reduced when the CAP algorithm is used indicating less bias than ADPS for some regions.

## Future improvements of the CDR and anticipated applications

### Quality Control

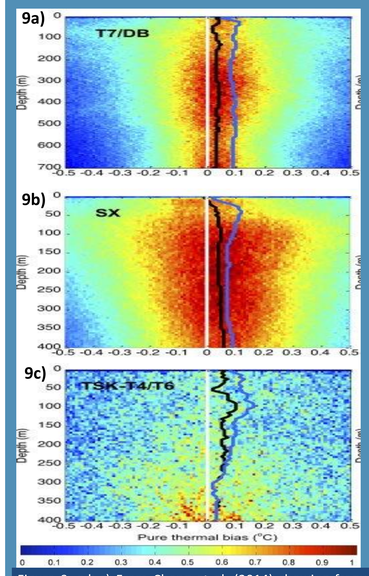



Figure 9. a,b,c) From Cheng et al. (2014) showing frequencies of pure thermal biases after individual corrections for the three instrument groups (T7, SX, TSK-T4/T6). Medians of the pure thermal bias at depths before (blue lines) and after (black lines) corrections.

Continued **quality control** improvement of the data used to calculate the temperature and salinity anomaly fields, heat and salt content, and steric sea level change is an important part of providing the best possible Climate Data Records. This includes correcting systematic XBT and ARGO biases since they contribute to a large portion of the data (See Fig. 3a).

**Satellite validation** of ongoing and future satellite missions such as the Soil Moisture Ocean Salinity (SMOS) satellite.

Other possible applications could be the development of regional ocean heat content time series (e.g. the tropical Pacific for El Niño monitoring and forecasting) and regional freshwater and salt content time series (e.g. subtropical Atlantic long term freshwater monitoring).

### Future Satellite Validation

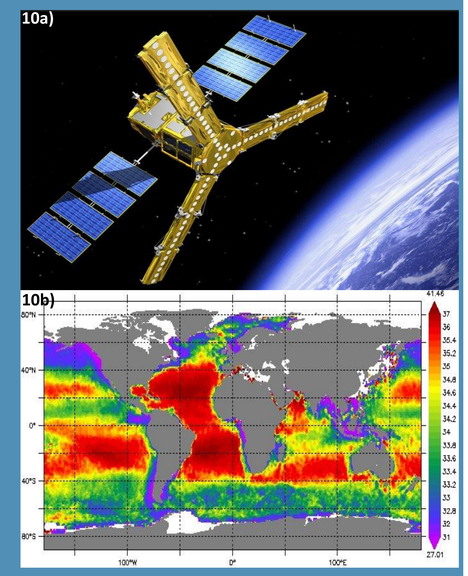



Figure 10. a) SMOS satellite. Fig. 10b. SMOS averaged sea surface salinity using Model 1 from March 2015.

## NOAA National Centers for Environmental Information

### NOAA Climate Data Record Program